1562792 COMPLETE SPECIFICATION
1 SHEET This drawing is a reproduction of the Original on a reduced scale

787

Fire proof glass

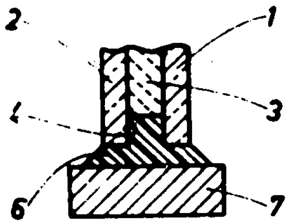

Fig.1.

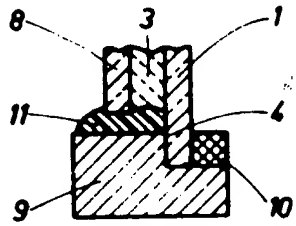

Fig.2.

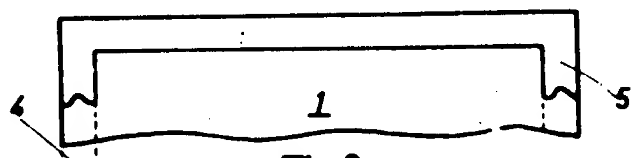

Fig.3.

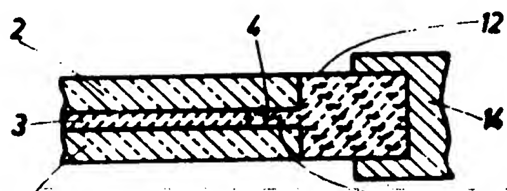

Fig.4.

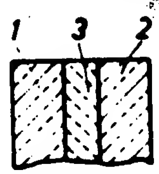

Fig.5.

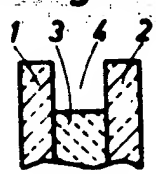

Fig.6.

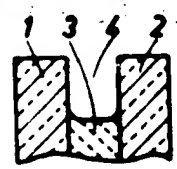

Fig.7.

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PATENT SPECIFICATION

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(54) LIGHT-TRANSMITTING FIRE-SCREENING PANELS

(71) We, BFG GLASSGROUP, Rue Caumartin 43 Paris, France, a Groupement [illegible] lished under the laws of France (French Ordinance dated 23rd September 1967) do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a laminated light-transmitting fire-screening panel comprising one or more layers of intumescent material, and is divided out of our copending application No. 34950/75 (Serial No. 1,562,791).

In the construction of buildings, light-transmitting panels have sometimes to be used in e.g. interior walls to form partitions, and such partitions have occasionally to satisfy certain standards of fire resistance. For example when a panel is exposed to a particular temperature cycle for a specified time, such standards may require that the panel should retain its strength without [illegible]ing, that it should be completely flame proof, that it should act as an infra-red radiation screening barrier and that the side thereof furthest from the source of heat should not become so hot as to involve serious risk of burning a person who touches it.

Clearly an ordinary glass sheet will not satisfy these requirements for any significant length of time, and it has accordingly been proposed to use laminated panels in which a layer of intumescent material is sandwiched between two sheets of glass. Such panels have been made by depositing a layer of intumescent material onto a first glass sheet, drying such layer, and bonding the layer to a second glass sheet by means of a layer of plastics material such as polyvinylbutyral. Although this has gone a long way towards meeting the standards referred to above for sufficiently long periods of exposure to fire, panels made in this way do suffer from certain disadvantages.

When such a fire-screening panel is held in a conventional frame channel, the lips of such channel will of course project over part of the panel faces, and accordingly, on the outbreak [illegible] fire there will be a considerable thermal gradient across the shielded margin of the panel so that the panel is apt to break [illegible] attendant thermal shock. [illegible] posals have been made in attempts to reduce this thermal shock. In a first such proposal, the lips of the frame are lengthened to cover wider margins of the panel and thus reduce the thermal gradient. In the second proposal, one face of the panel is placed against a more or less conventional frame lip and [illegible] is held in place by a plurality of [illegible] tongues bearing [illegible] second face [illegible] second proposal can work satisfactorily provided that fire breaks out on the side of the second face of the panel, since this allows substantially uniform heating thereof. Both said proposals suffer from the disadvantage that they do not make allowance for increase of thickness of the panel on intumescence of the sandwiched material. In fact, the thickness of an intumescent layer can increase by as much as a factor of ten or possibly even more on exposure to fire. In a typical practical example, an intumescent layer 2.5 mm thick can be sandwiched between two glass sheets each 4 mm thick to make a panel 10.5 mm thick before exposure to fire but which might expand to 33 mm thick after such exposure. Clearly such an expansion would place a very severe strain on the frame and on the structural plies of the panel.

The present invention aims to reduce or even eliminate this disadvantage.

Accordingly, as broadly described, the present invention provides a laminated light-transmitting fire-screening panel comprising one or more layers of intumescent material characterised in that the or at least one said layer of intumescent material is sandwiched between outer plies of the panel and in that the or at least one such layer occupies an area which is less than the area of at least one said outer ply to define a rebate leading along at least a portion of the edge of the panel.

A panel incorporating a said rebate can easily be mounted in a frame comprising one or more members leading around the panel and provided with elements for engagement with the rebate. In this way provision can

be made for the free relative movement of the outer plies of the panel on intumescence of the sandwiched material, and such a frame can also permit uniform heating of the whole extent of the panel on exposure to fire no matter on which side the fire breaks out.

Preferably, a said panel is mounted in a frame member which engages with said rebate [illegible] hold the panel so that its outer plies are free to move apart on intumescence of the layer or layers between them.

Alternatively, such rebate can be used to [illegible] a panel edge protecting [illegible] which serves to protect the edges of the panel from damage at least during transport. Such an edge protecting member can be given any suitable shape, for example so that it can be accommodated in a conventional [illegible] component in which case it [illegible] to the panel [illegible] constitute a portion of a frame.

In some embodiments of the invention, a said edge rebate is formed by applying intumescent material to cover substantially the whole area of a first outer ply and bonding that ply to a second outer ply with the intumescent material between them, which second ply is of [illegible] so that [illegible] is at least in part defined by the edges of the first ply and the intumescent material and a projecting lip formed by marginal portions of the second ply. In such embodiments, the second outer ply is preferably clamped in a conventional channel frame component.

In the most preferred embodiments of the invention, however, a said rebate is constituted as a groove formed in the thickness of the intumescent material. In such embodiments, it is preferable that a said frame comprises a tongue which engages in a said groove.

Alternatively, or in addition, such a rebate can be and preferably is used to accommodate sealing means protecting the intumescent material against contact with the atmosphere.

A said tongue is preferably glued inside a said groove, and this can be arranged to seal the intumescent material from the atmosphere without any supplementary sealing means. Adhesives based on neoprene, polyurethane or polysulphide are suitable.

Preferably, said sealing means is selected so that it will flow under the influence of heat due to the advent of a fire thereby to maintain sealing of the panel to its frame on intumescence of the sandwiched material.

Advantageously, said tongue is selected so that it will expand under the influence of heat due to the advent of a fire thereby to maintain sealing of the panel to its frame on intumescence of the sandwiched material.

The frame is preferably itself of fire-resistant material. For example the frame member(s) could be of ceramic, non-inflammable plastics material, concrete, metal, or wood which has been treated to make it fireproof. It is especially suitable to make a said frame member from an intumescent material, for example hydrated sodium silicate. Such intumescent material should be coated so as to protect it from the atmosphere if this is desirable, and the frame member may incorporate some form of reinforcement, for example fibres, such as glass fibres or a network of metallic threads, held in a matrix of the intumescent material. One such material is sold by Badische Anilin- & Soda-Fabrik A.G., under their Trade Mark Palusol, and comprises a body of hydrated sodium silicate having a coating of epoxy resin.

Embodiments of the invention wherein the frame comprises an intumescent material as aforesaid have the advantage that the frame can expand with expansion of the panel on exposure to fire thus maintaining support for [illegible]

A said groove in the thickness of said intumescent material can be formed in several different ways. For example such material could be initially applied to a said outer ply in such a way as to leave marginal zones thereof uncovered. Alternatively such a groove could be formed by dissolving away marginal portions of such material which [illegible] extended over the full area of the panel, or a groove could be mechanically cut around at least a part of the periphery of the panel, thus removing at least part of the thickness of the sandwiched intumescent material at marginal zones of the panel.

Advantageously, at least one and preferably both said outer plies are vitreous sheets.

The word "Vitreous" is used herein to denote articles made from glass or vitro-crystalline material. Vitro-crystalline materials can be made by subjecting glass to a heat treatment so as to induce the formation of one or more crystalline phases therein.

Advantageously, said intumescent material comprises a hydrated metal salt.

Examples of metal salts which can be used in hydrated form are as follows:

- Aluminates, e.g. sodium or potassium aluminate
- Plumbates, e.g. sodium or potassium plumbate
- Stannates, e.g. sodium or potassium stannate
- Alums, e.g. sodium aluminium sulphate or potassium aluminium sulphate
- Borates, e.g. sodium borate
- Phosphates, e.g. sodium orthophosphates, potassium orthophosphates and aluminium phosphate

Hydrated alkali metal silicates, e.g. sodium silicate, are especially suitable for use in a said layer of intumescent material.

Such substances have very good properties for the purpose in view. They are in many cases capable of forming transparent layers which adhere well to glass or vitro-crystalline

material. On being sufficiently heated, the combined water boils and the layers foam, so that the hydrated metal salt is converted into an opaque solid porous mass of cellular form in which it is highly thermally insulating and remains adherent to the glass or vitro-crystalline material.

This feature is particularly important, since [illegible] the structural plies of the panel are cracked or broken by thermal shock, the panel may retain its effectiveness as a barrier against heat and fumes since the fragments of the plies may remain in position bonded together by the converted metal salt.

In some embodiments, a layer of hydrated metal salt is used which is merely translucent, but preferably the hydrated metal salt forms a transparent solid layer at ambient temperature. [illegible] sodium aluminium sulphate [illegible] transparent layers. Preferably, the total amount of intumescent material applied is such as to form a layer in the finished panel of between 0.1 mm and 8 mm thick, preferably between 0.1 mm and 3 mm thick; such layer may for example be between 0.8 mm and 1.0 mm thick. Such layer thicknesses are found to be a good compromise between [illegible] before exposure to fire, and fire resistance.

The or each vitreous ply for assembly into the panel may be tempered, e.g. chemically tempered.

It has been found that vitreous sheets may suffer deterioration to varying degree by prolonged contact with various intumescent materials, e.g. hydrated metal salts. This is particularly important in the case of transparent or coloured sheets, since they may suffer a loss of transparency or undergo a change in colour.

Advantageously, therefore, a protective stratum is formed on at least one and preferably each vitreous ply face before said intumescent material is applied to such face, and said protective stratum is composed of a substance selected so as to inhibit interaction between said intumescent material and such ply face.

In some preferred embodiments, the protective stratum comprises a sheet of substantially water-impervious plastics material. Polyvinyl butyral is an especially suitable material for forming a plastics protective stratum, which may for example be 0.76 mm thick, though any other film-forming plastics material having the requisite properties may be used. In some embodiments of the invention the plastics protective stratum comprises a plastics material which has been polymerised in situ, such as polyurethane.

In other preferred embodiments of the invention there is at least one said protective stratum which comprises a coating applied to the vitreous sheet face to be protected. Such a protective coating preferably comprises an anhydrous metal compound deposited onto one or more ply faces, since such coatings can form very effective protective strata.

Preferably, said anhydrous metal compound is deposited by hydrolysis, since this is convenient in practice. Another very convenient way of depositing said anhydrous metal compound is by pyrolysis.

Preferably a said protective coating is between 100 and 1,000 Angstrom units thick, so as to provide a non-porous coating without giving rise to unsightly interference effects.

Clearly, one criterion affecting choice of a suitable coating material will be the composition of the intumescent material. By way of example, when said intumescent material comprises an hydrated metal salt selected from sodium aluminium sulphate, aluminium phosphate and alkali metal silicates, said anhydrous metal compound is preferably selected from [illegible] and anhydrous aluminium phosphate.

It is perhaps, surprising to note that a protective coating of anhydrous aluminium phosphate when deposited onto a vitreous sheet will serve substantially to prevent interaction between that vitreous sheet and an adjacent layer of hydrated aluminium phosphate.

This invention does not exclude [illegible] other materials. For example, when said intumescent material comprises hydrated aluminium phosphate, titanium oxide and tin oxide are also eminently suitable coating materials.

Alternatively, or in addition, a coating having other properties may be applied to a vitreous sheet of the panel. For example an infra-red reflecting coating of a noble metal, copper, aluminium or an oxide may be applied and this will have the advantage of affording some protection for the intumescent material against the absorption of infra-red radiation which could cause the intumescent material to become opaque and blister even before the advent of fire. Furthermore, the use of such an infra-red reflecting coating can increase the time taken for the layer to intumesce on the outbreak of fire, and this will in turn increase the time for which protection is given.

Another way of giving longer protection is to make the panel using two layers of intumescent material which are separated by a fluid impervious membrane. When such a panel is exposed to fire, the intumescent layer nearer the fire will intumesce, but the other layer will not be converted by the heat until intumescence of the first layer is substantially complete. A said membrane may be made from polyvinyl butyral, which bonds the layers together. It will be appreciated that a polyvinyl butyral membrane can also be used to bond a single layer to a vitreous sheet.

Preferably the groove is at least 2 mm deep. The adoption of this feature allows an improvement in keying between the panel and the frame. The groove may be between 4 mm and

10 mm deep, for example it may be approximately 6 mm deep.

It is possible for a said rebate to be formed in distinct portions, but it is preferably continuous around the panel.

The invention will now be described by way of example with reference to the accompanying diagrammatic drawings, in which: [illegible] 1 and 2 are cross-sectional views of two embodiments of fire-screening panel according to the invention; Figure 3 is a detail view of a mask applied to a sheet prior to the [illegible] of intumescent material; and Figures 4 to 7 are detail edge elevations of fire-screening panels.

Example 1

A fire screening panel was made as shown [illegible] and 3. This panel comprises two [illegible] mm thick [illegible] first of which a layer 3 of intumescent material 2.5 mm thick has been applied.

In order to form the layer 3, hydrated sodium aluminium sulphate was applied in an aqueous solution.

This solution was applied to a face of the first glass sheet while it was substantially [illegible] and [illegible] temperature of [illegible]°C. The solution was allowed to spread out over the sheet and was dried by directing a current of warm air across the sheet using a fan. When the layer had become dry it was bonded to the second glass sheet 2.

In order that this panel should conform with the invention, a groove 4 was provided leading around the periphery of the panel. This was done by placing a mask 5 (Figure 3) over the first sheet 1 prior to the application of the intumescent material. The mask occupied the marginal zone of the sheet which would define the depth of the groove 4 in the finished panel. In a variant method of manufacture, intumescent material is applied to the whole of the first sheet 1 to give an edge profile as shown in Figure 5 and a groove is cut in the edge thereof by removing the hydrated sodium aluminium sulphate over a marginal zone to define a groove 4 leading around the panel, as is illustrated in Figure 6.

In a variant of this Example, the layer of hydrated sodium aluminium sulphate was applied over the whole area of the first sheet and dried as before and the thus coated sheet was then immersed in a bath of water. The second sheet 2 was then slidden into registry and the thus assembled panel was left in the bath for a sufficient time for the marginal zone of the sandwiched layer to have been dissolved away to leave a groove 4 as shown in Figure 7.

In a further variant, the face of each of the sheets of glass which was to be interior of the panel was protected from direct contact with the intumescent material by applying thereto a protective coating of anhydrous aluminium phosphate 500 Angstrom units thick.

Such a coating can be formed as follows. A solution in alcohol containing one mole of anhydrous aluminium trichloride and one mole of anhydrous phosphoric acid is prepared. This can be applied to the upper faces of horizontally laid sheets of glass and allowed to spread out to form a uniform covering. The sheets are dried and placed in a furnace heated to 400°C. This gives a strongly adherent coating of anhydrous aluminium phosphate.

As will be noted from Figure 1, the groove 4 along the edge of the panel is filled with a body of sealing material 6 which also serves to seal the panel into a frame, part of which is shown at 7. The sealing material 6 may be a neoprene based adhesive.

On the outbreak of fire on one side of the pa[illegible]strated in Figure 1, the [illegible] layer will intumesce, and the sealing material 6 will become softened. Due to the build up of pressure between the glass sheets, they will move apart, and also, the intumescing material in the layer 3 will be forced out around the edges of the panel displacing the sealing material 6 in the groove 4 to form a [illegible] barrier extending [illegible]

In a variant of this embodiment, the frame member 7 is provided with a tongue which is glued into the groove 4 to locate the panel.

Example 2

A fire-screening panel was made as shown in Figures 2 and 3. A glass sheet 1 was coated with an intumescent layer 3 of hydrated aluminium phosphate 5 mm thick. The sheet was laid horizontally and a masking frame 5 was laid to occupy marginal zones of the sheet (Figure 3) which define the rebate 4 (Figure 2). An aqueous solution of 3.5 moles of hydrated aluminium phosphate was obtained by mixing hydrated aluminium chloride ($AlCl_3 . 6H_2O$) and phosphoric acid (H_3PO_4), and this was then poured onto the horizontal sheets and dried by ventilation with warm air.

A second sheet 8 was then assembled and bonded to the layer 3 deposited on the first sheet 1. As will be noted from Figure 2, this sheet 8 was of substantially the same area of the layer 3, so that there is no groove, but rather a rebate 4 leading around the edge of the panel. This embodiment has the advantage of enabling the first glass sheet 1 to be fixed into a conventional type of frame comprising an L-section member 9 and a retaining strip 10. The second sheet 8 is sealed to the L-section frame member 9 using a body 11 of heat-flowable sealing material.

When a panel according to this embodiment is exposed to fire, the first glass sheet 1 will remain fixed in the frame 9, 10, but because of the shape of the frame, the second glass sheet 8 is free to move away from the first

sheet on intumescence of the sandwiched material.

In order to reduce the effects of thermal shock at the edge of the first sheet 1 should fire break out on that side of the panel, the retaining strip 10 may be made of a heat conductive material, for example a metal, such as aluminium. Alternatively the strip may be [illegible] by a series of short, spaced retaining members. It is not necessary to take such precautions to guard against thermal shock due to outbreak of fire on the other side of the [illegible] the insulation afforded the edges of the first sheet 1 by the L-section member 9 will be largely balanced by the insulation afforded by the second sheet 8 and the sandwiched layer.

In a variant of this Example, one face of [illegible] Angstrom unit [illegible] by the well-known hydrolysis process.

Example 3

A fire-screening panel according to the invention was made in accordance with Figures 3 and 6. In Figure 6, two glass sheets 1, 2 were each 4 mm thick and provided with a stratum [illegible] sodium [illegible] thick, and these strata were bonded together to form a 5 mm layer 3. In order to form the layer 3, hydrated sodium silicate was applied to each sheet in an aqueous solution having the following properties:

Proportion by weight SiO_2 : Na_2O = 3.4
Viscosity = 0.2 poiseuille
Specific Gravity 37°—40° Baumé

This solution was applied to a face of each horizontally laid sheet at a temperature of 20°C, and was allowed to spread out over the sheets. Each layer was then dried by ventilation with air at 35°C and 50% relative humidity. This drying has the effect of driving off excess, unbound water of solution to leave a layer of hydrated sodium silicate on each glass sheet. After formation of these layers of hydrated sodium silicate on the sheets, the sheets were bonded together, so as to leave a groove 4 extending round the assembled panel.

The panel thus formed may be placed in a frame very easily and is further very advantageous in the case of a fire. It should be noted that on the advent of fire the layer 3 of hydrated sodium silicate intumesces and is converted to an anhydrous mass having an opaque porous form.

The panel has a high degree of mechanical stability during and after intumescence of its sandwiched layer.

In a variant embodiment shown in Figure 6, use was made of glass sheets 1 and 2 which had been subjected to a chemical tempering treatment involving diffusion of ions into the glass from a contacting medium. This chemical tempering was an exchange of sodium ions from surface layers of the treated sheets by potassium ions from the contacting medium which comprises a bath of molten potassium nitrate maintained at a temperature of 470°C. The result obtained from the point of view of thermal insulation, mechanical stability and effectiveness as a flame- and fume-proof barrier were analogous to those obtained with the fire screening panel above described. However, this variant has a greater resistance to thermal shock during the first few minutes of a fire than does the panel described above.

In a second variant for use in situations where there is only a very slight fire risk on one side of the partition, the sheet of glass 1 to be directed towards that side is replaced by a sheet of plastics material. Again, the results obtained from the point of view of resistance [illegible] similar to those above.

In a third variant, a fire-screening panel was constructed exactly as described at the beginning of this example, except that the strata of hydrated sodium silicate were formed to a thickness of 0.2 mm. instead of 2.5 mm. From the point of view of fire resistance, this variant panel is slightly less effective than [illegible] described above. However, [illegible] does have the advantage of increased transparency.

In yet a further variant embodiment, a stream of water is directed against the edges of the laminate further to dissolve away the layers of intumescent material over marginal zones of the panel. A sealing compound, e.g. a neoprene based adhesive can be introduced into the enlarged groove to protect the intumescent material from deterioration as a result of contact with the atmosphere, and this adhesive can also serve to hold a framing component in the groove.

Example 4

Figure 4 shows a detail of a panel according to the invention comprising two vitreous sheets 1, 2 with a layer 3 of intumescent material sandwiched between them. A framing component generally indicated at 12 has a tongue 13 which is glued inside a groove 4 formed between the two vitreous sheets.

This gluing also serves to seal the intumescent layer in the completed panel from the atmosphere.

In a particular practical example, the framing component was made by laminating together strips of Palusol (Trade Mark of Badische Anilin- & Soda-Fabrik A.G.) which as has been stated is available as a composite material comprising glass fibres or a network of metallic threads embedded in a matrix of hydrated sodium silicate and coated with epoxy resin. This material is available in sheets 1.8 mm thick. It is accordingly convenient to make the intumescent material 2 mm thick if the tongue 13 is to consist of a single strip. The framing component 12 may be held in a

conventional channel frame 14. The fact that on the outbreak of fire the framing component will intumesce and accordingly expand is an important advantage especially if it is not confined over the whole of its surface, in that as the intumescent layer 3 expands, so will the tongue 13, and bonding of the frame component to both glass sheets can be maintained.

[illegible] intumescent layer 3 was formed by depositing on each of the vitreous sheets 1, 2, a stratum 1 mm thick of hydrated sodium silicate: this was done in the same way as was described in Example 3.

After drying these strata of intumescent material, the first sheet was laid in a bath of sodium hydroxide solution and the second sheet was slidden across the first to bring the strata into contacting registry. The assembly [illegible] for several hours until [illegible] sodium silicate had been dissolved away to leave a groove 4 about 6 mm deep as shown in Figure 4.

In a variant of this Example, the tongued framing component can be made of metal, for example aluminium alloy. In such a case the framing component which can be formed by extrusion may be given a shape which will [illegible] e.g. by [illegible] into a window space: the channel member 14 can then be dispensed with.

WHAT WE CLAIM IS:—

1. A laminated light-transmitting fire-screening panel comprising one or more layers of intumescent material characterised in that the or at least one said layer of intumescent material is sandwiched between outer plies of the panel and in that the or at least one such layer occupies an area which is less than the area of at least one said outer ply to define at least one rebate leading along at least a portion of the edge of the panel.

2. A panel according to claim 1, characterised in that said panel is mounted in a frame member which engages with said rebate to hold the panel so that its outer plies are free to move apart on intumescence of the layer or layers between them.

3. A panel according to claim 1 or 2, characterised in that such rebate is used to assist in locating a panel edge protecting member.

4. A panel according to any preceding claim, characterised in that a said rebate is constituted as a groove formed in the thickness of the intumescent material.

5. A panel according to claims 2 and 4, characterised in that a said frame comprises a tongue which engages in a said groove.

6. A panel according to any preceding claim, characterised in that a said rebate is used to accommodate sealing means protecting the intumescent material against contact with the atmosphere.

7. A panel according to claim 6, characterised in that said sealing means is selected so that it will flow under the influence of heat due to the advent of a fire thereby to maintain [illegible] panel to its frame on intumescence of the sandwiched material.

8. A panel according to claim 5, characterised in that said tongue is selected so that it will expand under the influence of heat due to the advent of a fire thereby to maintain sealing of the panel to its frame on intumescence of the sandwiched material.

9. A panel according to any [illegible] characterised in that both said outer plies are vitreous sheets.

10. A panel according to any preceding claim characterised in that said intumescent material comprises a hydrated metal salt.

11. A panel according to claim 10, characterised in that the hydrated metal salt forms a transparent solid layer at ambient temperature.

12. A panel according to claim 10, characterised in that said salt is hydrated sodium silicate.

13. A panel according to claim 1 and substantially as described in any one of the Examples herein set forth.

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